MARKER CODE				

STUDENT ENROLMENT NUMBER (SEN)									

TONGA NATIONAL FORM SEVEN CERTIFICATE

2025

CHEMISTRY

QUESTION AND ANSWER BOOKLET

Time allowed: 3 Hours

INSTRUCTIONS:

1. Write your **Student Enrolment Number (SEN)** on the top right-hand corner of this page.
2. This paper consists of **FIVE SECTIONS** and is out of 70 weighted scores.

SECTION	STRANDS	TOTAL SKILL LEVEL
ONE	THERMOCHEMICAL PRNCIPLES AND PROPERTIES OF PARTICLES AND SUBSTANCES	12
TWO	INORGANIC CHEMISTRY	10
THREE	QUANTITATIVE CHEMISTRY	19
FOUR	REDOX CHEMISTRY AND NUCLEAR CHEMISTRY	12
FIVE	ORGANIC CHEMISTRY	17
	TOTAL	70

3. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.
4. Use a **BLUE** or **BLACK** ball point pen only for writing. Use a pencil for drawing if required.
5. If you need more space for answers, ask the supervisor for extra paper. Write your **Student Enrolment Number (SEN)** on each additional sheet, number the questions clearly and insert them in the appropriate places in this booklet.
6. **NOTE: PERIODIC TABLE** is provided.
7. Check that this booklet contain pages **2-15** in the correct order and that none of the pages is blank.

YOU MUST HAND IN THIS BOOKLET TO THE SUPERVISOR BEFORE YOU LEAVE THE EXAMINATION ROOM.

SECTION ONE: THERMOCHEMICAL PRINCIPLES AND PROPERTIES OF PARTICLES AND SUBSTANCES

1. Electron configuration for a few atoms of the periodic table is shown below:

   Cu - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

   Fe - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

   Zn - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$

   a. Write the **ground electron configuration** using s,p,d,f notation for Iron (III) ions.

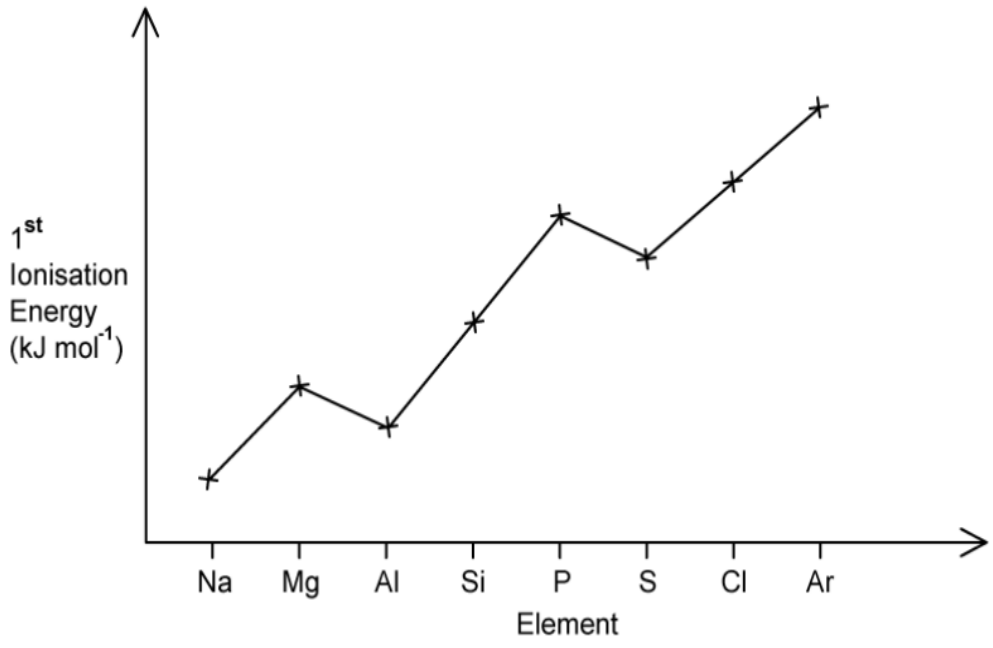
Skill level 2	
2	
1	
0	
NR	

   b. Describe **how** electron configuration of Cu is differed from Fe and Zn.

Skill level 2	
2	
1	
0	
NR	

2. The graph below shows the first ionization energy of period 3 elements in a periodic table.

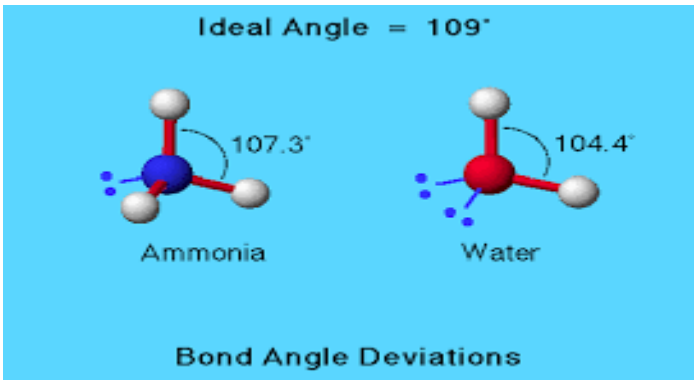
   The general trend of the first ionization energy increases across the period. Study the graph carefully to answer the question that follow:



Describe **why the first** Ionisation Energy of Aluminium (Al) is lower than magnesium (Mg).

Skill level 2	
2	
1	
0	
NR	

3. The structure below shows the ideal bonding angle for water and ammonia is 109^0 whereas their observed bonding angles is respectively 104.4^0 and 107.3^0.



Explain why the ideal bonding angles of ammonia and water **differ** from the observed angles.

Skill level 3	
3	
2	
1	
0	
NR	

4. **Calculate** the standard enthalpy change of combustion of propane, given the equation:

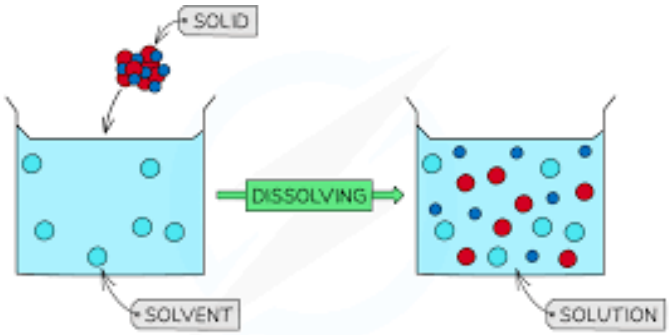
$$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(l)}$$

Bond	**enthalpy (kJ mol-1)**
C-H	+413
C-C	+347
O=O	+498
C=O	+805
O-H	+464
Enthalpy change of vaporisation of water = +41 kJ mol^{-1}	

Skill level 3	
3	
2	
1	
0	
NR	

SECTION TWO: INORGANIC CHEMISTRY

1. The diagram shows solid sodium chloride is added to a beaker of water and is dissolved to form a solution.



Describe how **entropy change** affects dissolution process of sodium chloride in water.

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_____

Skill level 2	
2	
1	
0	
NR	

2. Common copper(II) complex ions include $[Cu(H_2O)_6]^{2+}$, $[Cu(NH_3)_4]^{+2}$ and $[CuCl_4]^{-2}$.

a. Write a **balanced equation** for the formation of $[Cu(NH_3)_4]^{+2}$.

Skill level 2	
2	
1	
0	
NR	

b. State the **colour** of $[Cu(NH_3)_4]^{+2}$.

_____

Skill level 1	
1	
0	
NR	

c. **Name** the complex ion $[CuCl_4]^{-2}$.

Skill level 2	
2	
1	
0	
NR	

3. The table below shows some transition metal ions with their colours:

TRANSITION METAL IONS	COLOUR
Cobalt(II) ions $[Co(H_2O)_6]^{2+}$	pink
Cobalt(II) ions $[CoCl_4]^{2-}$	blue
Copper(II) ions $[Cu(H_2O)_6]^{2+}$	blue
Copper(II) ions $[Cu(Cl_4)]^{2-}$	yellow

Explain **why majority** of the transition metal ions are **coloured.**

_____

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Skill level 3	
3	
2	
1	
0	
NR	

SECTION THREE: QUANTITATIVE CHEMISTRY

1. Ammonia can be produced by the reaction between hydrogen and nitrogen gas that is represented by the following equation:

$$3H_2 + N_2 \rightleftharpoons 2\,NH_3$$

5 mol of nitrogen gas and 5 mol of hydrogen gas are placed in a sealed vessel that has a volume of 20mL at 500K at equilibrium, only 0.25 mol of nitrogen would be converted into ammonia.

Calculate the value of $\mathbf{K_c}$ at this temperature, giving the answer to 3 decimal places.

Skill level 3	
3	
2	
1	
0	
NR	

2. The solubility product of copper hydroxide $Cu(OH)_2$ is 4.8×10^{-20}. Calculate the **solubility** of $Cu(OH)_2$.

Skill level 3	
3	
2	
1	
0	
NR	

3. Methanoic acid, also known as formic acid, HCOOH is a weak acid.
   a. Write the **expression** for the acid dissociation Ka of methanoic acid.

Skill level 2	
2	
1	
0	
NR	

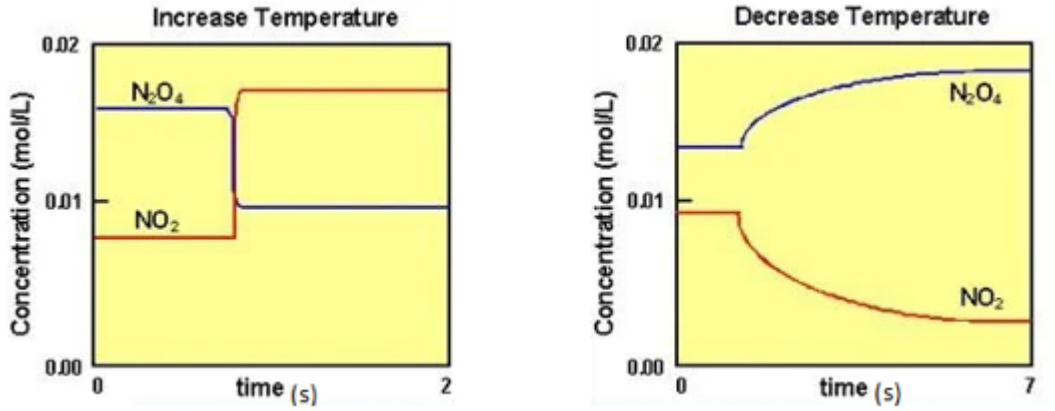
b. Calculate the pKa of a 0.200 mol L^{-1} solution of methanoic acid given the pH = 2.22.

Skill level 3	
3	
2	
1	
0	
NR	

4. Nitrogen dioxide NO_2 undergoes an equilibrium reaction to produce Dinitrogen tetroxide N_2O_4.

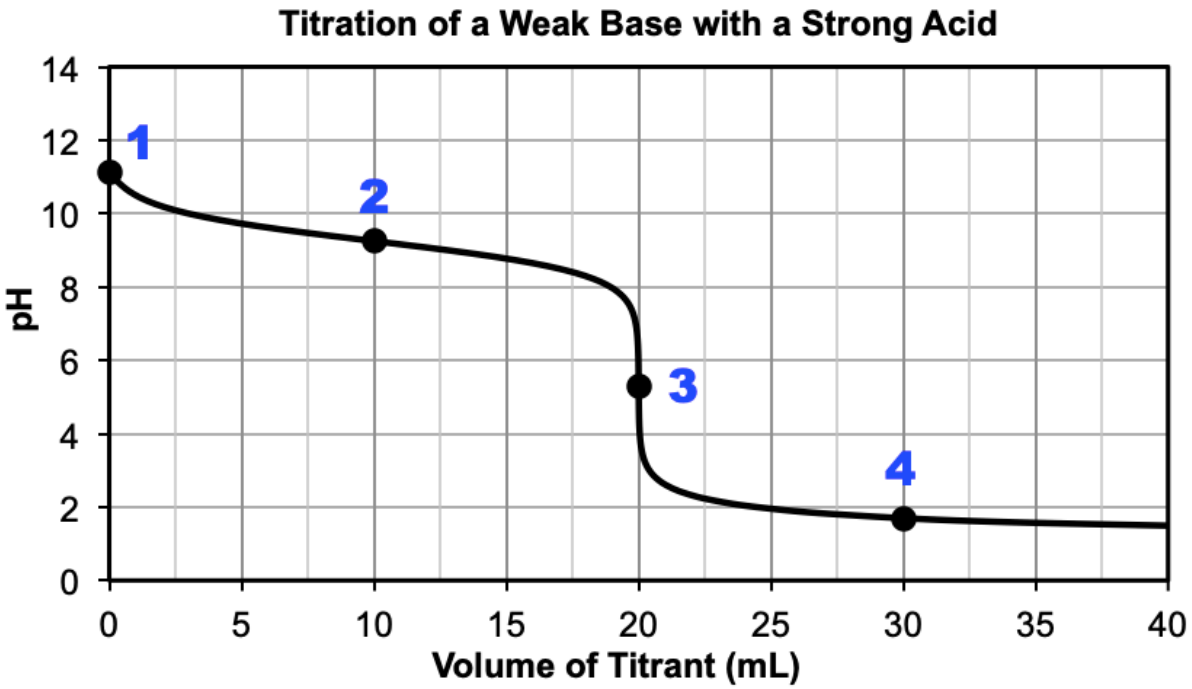
$$2NO_{2\,(g)} \rightleftharpoons NO_{2\,(g)} \quad \Delta H = 58.0\ kj/mol$$

Study the diagram below to **discuss** the effect of the **equilibrium position** when there are **changes to the temperature** of the system.



Skill level 4	
4	
3	
2	
1	
0	
NR	

5. The titration curve shows the titration between ammonia and hydrochloric acid. Use the titration curve below to **discuss the changes in pH** numbered as 1 to 4 in terms of the **species present** in the solution during the titration.



Skill level 4	
4	
3	
2	
1	
0	
NR	

SECTION FOUR: REDOX CHEMISTRY AND NUCLEAR CHEMISTRY

1. Oxalic acid, $H_2C_2O_4$ reacts with acidified potassium dichromate, $K_2Cr_2O_7$. The reaction is known as an oxidation-reduction reaction.

   Write an **overall balanced equation** for the redox reaction in terms of the ion-electron method.

   $$H_2C_2O_4 + Cr_2O_7^{-2} \longrightarrow 2Cr^{+3} + CO_2$$

Skill level 3	
3	
2	
1	
0	
NR	

2. An electrolytic cell has two half-cells:

   $$Zn^{+2}(aq) + 2e^- \longrightarrow Zn\ (s) \quad E^0 = -0.76\ V$$

   $$Cu^{+2}\ (aq) + 2e^- \longrightarrow Cu\ (s) \quad E^0 = +0.34\ V$$

   Given the E^0 values, **predict** whether the reaction is **spontaneous or not**.

Skill level 3	
3	
2	
1	
0	
NR	

3. An isotope of protactinium-234 has a half-life of 1.17 minutes.

a. **Define** half-life.

Skill level 1	
1	
0	
NR	

b. **Calculate** the amount of **time** it takes for a sample to decay from a mass of 10 mg to 2.5 mg.

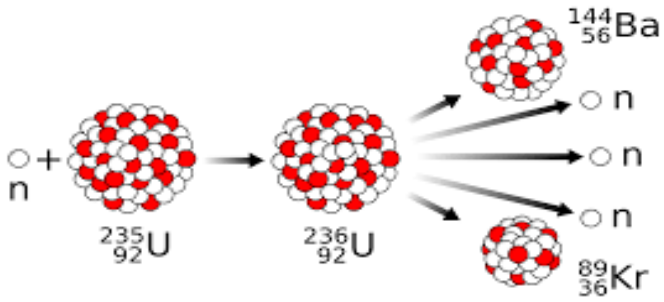
Skill level 2	
2	
1	
0	
NR	

4. By emitting an alpha particle, an atom of uranium-235 decays into an atom of thorium.

Complete the **nuclear equation** for the above reaction.

Skill level 2	
2	
1	
0	
NR	

5. The diagram shows an atom of uranium-235 being split into several pieces.



Name the **type of reaction** shown in the diagram above.

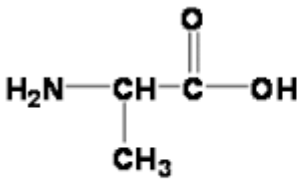
Skill level 1	
1	
0	
NR	

SECTION FIVE: ORGANIC CHEMISTRY

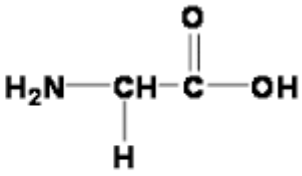
1. Explain the **reaction mechanism** that occurred when an alcohol reacts with Lucas Reagent.

Skill level 3	
3	
2	
1	
0	
NR	

2. The structures below are examples of amino acids. Study the structures carefully to explain which amino acid can exhibit **optical isomerism**.



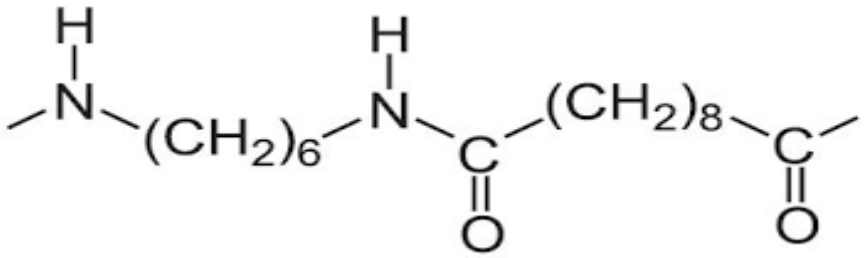
alanine



glycine

Skill level 3	
3	
2	
1	
0	
NR	

3. The repeating unit of **Nylon 6,10** is shown below.



Write the **monomers** of nylon 6,10.

Skill level 2	
2	
1	
0	
NR	

4. Write the **structural formula of the products** formed from the reaction of ethanoyl chloride and ethyl amine.

$$CH_3COCl + 2\ CH_3CH_2NH_3 \longrightarrow$$

Skill level 2	
2	
1	
0	
NR	

Name the main product formed from the reaction.

_____

Skill level 1	
1	
0	
NR	

5. Write a **balanced equation** for the **reaction** of chloroethane with potassium hydroxide in alcohol then **name** the type of reaction involved.

Skill level 2	
2	
1	
0	
NR	

Type of reaction: _____

Skill level 1	
1	
0	
NR	

6. Write a **balanced equation** for the **conversion** of chloroethane to alcohols then name the type of reaction involved.

Skill level 2	
2	
1	
0	
NR	

Skill level 1	
1	
0	
NR	

Type of reaction: _____